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(54) METERING PUMPS

(71) We, WILHELM HEDRICH VAKUUMANLAGEN GMBH & CO. KG., organised and existing under the laws of the Federal Republic of Germany, of D-6331 Katzenfurt, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:–

This invention relates to apparatus for measuring or supplying measured quantities of fluids in the form of liquid or highly viscous media, all of which are included in the general term "liquids" used in the following description and claims.

Where a number of liquid components, some of which may be more viscous than others, are to be mixed together, they must generally be brought to a uniform consistency before they are admixed. To produce the finished product correct proportions, which may be stoichiometric, of these individual components must be mixed together. The required quantities of these liquids, which have to be accurately controlled, have hitherto generally been conveyed into mixing chambers by means of metering pumps, which are arranged either in conduits connecting the containers or actually in a stirring or mixing chamber. These two arrangements suffer, however, from the disadvantages that, on the one hand, it is only possible to maintain the required uniform temperatures over long conduits at a considerable expense while, on the other hand, the use of such long conduits means that the materials take an unnecessarily long time to pass through them, which is undesirable, especially when the setting time or pot life of the materials is important.

If the pump is arranged within the mixing chamber it is operated by a driving shaft, which is usually driven from the cover side of the container simply through the interior of the container. In the case of the last-mentioned proposals, the driving shafts become encrusted, as do the valve seats, so that the quantities discharged are not uniform. There is also the related disadvantage that the discharge times, more particularly for materials which are highly viscous and are under a vacuum, have been considerably prolonged.

An attempt has been made to overcome these disadvantages by using a two-part container, the lower part of which is moved axially relatively to the upper part, and has, arranged in it and connected to an agitating device, a kind of needle valve against which the lower part of the container is pressed by raising it. With this arrangement, however, the quantity of material to be ejected depends entirely on the viscosity of the material remaining absolutely uniform while its rate of flow continually varies when the valve is opened, that is to say when the lower part of the container is lowered.

The possibility of conveying both liquid and highly viscous compositions in uniform quantities, in each case at equal intervals of time even under a vacuum from one container into a nearby container and of ejecting it quickly from the latter in equal quantities, could not be achieved with this arrangement.

The present invention has as amongst its objects to obviate or reduce the aforesaid disadvantages by the provision of apparatus which can be driven from the outside, which is suitable for both very liquid and highly viscous materials and, more particularly, which can also be adjusted in an infinitely variable manner to suit the material to be dealt with, and which can be under a vacuum. It has been found possible, without having to convert existing installations, to obtain immediate and precise metering, and therefore higher and better production, especially for high-quality mass-produced articles.

This object can be achieved by using a

pump for delivering and/or metering liquids comprising a pumping cylinder the temperature of which can be controlled and which is formed with sections of different diameters, and a pumping and/or metering piston operating in the cylinder, wherein the cylinder is provided with an inlet passage at its end opening into the section of larger diameter, means for securing this end of the cylinder to a container supplying the liquid, the pumping piston being reciprocable in the smaller diameter section of the cylinder, a valve member carried by the pumping piston and projecting from it for reciprocating engagement in the inlet passage, an outlet for the liquid leading from the larger diameter section of the cylinder, a non-return valve in the outlet, a piston rod connected to the pumping piston and projecting from the cylinder and adjustable abutments for limiting the travel of the pumping piston.

According to one arrangement the valve member is in the form of a piston which is fixed to the pumping piston and which closes the inlet passage when it enters the inner end of the latter.

The piston may be hollow with a port opening into the cylinder and contains a spring-loaded buffer piston movement of which against the spring force absorbs surges of pressure at the times of closing of the inlet passage.

Metering is effected by the suction travel of the valve piston along the inlet passage, which acts as a valve seat, into the metering chamber, while when it leaves the valve seat there is an increase in the internal cross-section and in the suction force due to the substantially larger diameter of the pumping and metering section of the cylinder, so that the metering chamber is quickly filled. Reversing the direction of travel of the piston brings about the closing of the inlet valve and the discharge of the liquid composition or material, which had hitherto been kept in the metering chamber by the outlet valve, to the next processing, filling or mixing station.

According to another arrangement the valve member operates and contains a non-return valve allowing the passage of liquid from the inlet passage to the cylinder.

The provision of the valve piston with such a non-return valve, which closes in the direction of the dispensing container, is used advantageously when the valve piston does not leave the inlet passage or in other words the valve seat. In such a case it is possible, for example, to process a material which might, because of a too-great inlet pressure, flood the metering chamber by way of the non-return valve, before the valve piston has left its seat.

An extension of the use of the invention is possible by providing a buffer piston in the valve piston. This advantageously achieves the result that the high speed of flow which occurs as the valve piston approaches the inlet passage up to the moment of closing is substantially reduced in the narrow section part of the cylinder since the displaced liquid is received in the valve piston.

A further advantageous feature of the invention is to make the cylinder of double-wall construction and to surround it with heating and/or cooling means controlled by temperature sensing elements.

The pumping and/or metering piston is also surrounded in the region of its guided length with sealing elements or rings, more particularly ones made of a barrier material. Also the axial movement of the piston assembly is capable of being limited by adjustable abutments or stops, preferably in the region of the driving member which operates the pump.

The advantages which are obtained with the present invention consist primarily in that, instead of having moving and pumping elements for the outlet valves arranged within the mixing vessels or reaction containers which require a complicated sealing arrangement for outwardly extending driving shafts to operate them, more particularly for vacuum vessels, the drive elements can be located outside the pumping chamber. Furthermore the metering pumps, which were previously also arranged within the chamber and were difficult to control and which were also driven from outside, are now replaced by the pumping and metering apparatus according to the present invention and, at the same time, there is no need for special inlet or outlet valves, these being replaced by the proposed valve piston. A further advantage is the simple assembly of the pumping and metering apparatus, which can be fitted without any great outlay, simply by the provision of a flange or other mounting means and an inlet passage which will connect with the outlet bore which is usually present on vessels containing liquid or highly viscous materials for the purpose of dispensing exact portions of the contents thereof.

Constructional examples of the invention are shown diagrammatically in the accompanying drawings, in which:–

Fig. 1 shows a part-sectional view of a pump for delivering and/or metering liquids, which pump includes a valve seat, a valve piston, a metering chamber and a pumping piston;

Fig. 2 is a part section through the cylinder and piston of a pump which is similar to that shown in Figure 1 but which has a non-return valve with its seat arranged in the pumping piston;

Fig. 3 is a part section through a pump which is similar to that shown in Fig. 1 except that the valve piston has a buffer piston arranged in it, in place of the non-return

valve of Fig. 2.

Referring to Fig. 1, this shows a pump having a cylinder, indicated generally at 1, which is provided at one end with a flange 2 by which it can be connected to a container of any desired shape containing the liquid to be pumped and metered without requiring the provision of a special supply conduit for delivering the liquid within the container to the pump, by which it is then delivered to a further processing or treatment station. The transfer of the liquid from the container to the metering chamber 5 of the pump shown in Fig. 1 is effected by suction when a valve piston member 10 provided on the end of the pumping piston 9 leaves the lower end of its valve seat, which is of hollow cylindrical form as shown at 3 and is provided by the inlet passage 4 of the pump. When the valve piston 10 leaves its seat 3 during downward travel of the piston 9 liquid from the container quickly fills the chamber 5 as a result of the vacuum produced by the travel of the piston 9.

This arrangement is particularly advantageous for delivering liquids from vacuum vessels where there is only a small difference in level at the inlet. The suction effect is, however, also of importance for very viscous liquids, since it is possible during the suction stroke to overcome easily the frictional resistance which is present with such viscous liquids and tends to increase the resistance to flow in the inlets to pumps. Thus the apparatus of the invention is particularly suitable for delivering and/or metering components of casting resins which are prepared under reduced pressure and which have to be discharged as quickly as possible because they have only short pot lives before they begin to set. The invention reduces the risk of passages becoming blocked, as has often happened in the past.

The apparatus of the invention is also suitable for use with compositions, such as highly viscous casting resin components which are enriched with fillers, such as quartz powder, asbestos or the like, and which are liable to form sediments even in the mixing chamber. Any such accumulations in the apparatus of the invention, which would generally collect near the outlet passage 6 from the mixing chamber, are ejected during the discharge or pumping period by the pressure produced in the chamber 5 by the piston 9, while parts of it are broken up and returned to the chamber by the valve piston 10. This piston also has the effect of producing a scavenging and cleaning action in the inlet 4.

As shown in Fig. 1 the cylinder 1 is surrounded by a jacket 18 and is provided with one or more heating and/or cooling elements 18*a*, which are controlled automatically by temperature-responsive means (not shown) to keep the cylinder at the correct temperature.

In order to obtain precise metering of the quantities to be delivered at each stroke through the passage 6, which is provided with a non-return valve 7, adjustable stops 11 are provided to enable the stroke of the piston 9 to be adjusted so that the amounts delivered at each stroke can be varied as desired from zero to a maximum value. The pumping and metering operation itself begins at the moment when the valve piston 10 closes the inlet 4 and it ends when an abutment 11 limits the upward stroke of the piston.

A modified form of pump is shown in Fig. 2, in which the piston 10, which in this case always operates within the passage 4, is provided with its own non-return ball valve which is spring-biased into a closed position in which it closes an opening 15 formed in the centre of the end face of the piston 10, which piston is also formed with outlet ports 16. This non-return valve allows liquid to flow past it and through the ports 16 into the chamber 5 during downward travel of the piston 9. During upward travel of the piston 9 the aperture 15 is closed so that liquid from the chamber 5 is discharged through the outlet 6. Control of the stroke is by abutments 11 (Fig. 1).

Another modification, which is very useful for some particular purposes, is shown in Fig. 3. In this one the valve piston 10, which operates in the passage 4 in a similar manner to the one shown in Fig. 1, is provided with a buffer piston 17. This buffer piston limits the build up of pressure in the chamber 5 which occurs in the metering chamber 5 as the end of the piston 10 enters the inlet passage 4, which latter provides the valve 3, as was the case with Fig. 1. This is advantageous with some liquids since, in this way, the high speeds of flow which occur during a pressure build-up shortly before the moment of closure, when there is a rapid narrowing of the passage through which the liquid is flowing, are substantially reduced, since excess liquid is received in the piston 10 due to the displacement of the spring-biased piston 17. The main advantage of this construction is found when liquids containing abrasive particles are being used which might damage the walls of the cylinders and pistons. This arrangement can be given a substantially longer life.

WHAT WE CLAIM IS:-

1. A pump for delivering and/or metering liquids comprising a pumping cylinder the temperature of which can be controlled and which is formed with sections of different diameters, and a pumping and/or metering piston operating in the cylinder, wherein the cylinder is provided with an inlet passage at its end opening into the section of larger diameter, means for securing this end of the cylinder to a container supplying the liquid,

the pumping piston being reciprocable in the smaller diameter section of the cylinder, a valve member carried by the pumping piston and projecting from it for reciprocating engagement in the inlet passage, an outlet for the liquid leading from the larger diameter section of the cylinder, a non-return valve in the outlet, a piston rod connected to the pumping piston and projecting from the cylinder and adjustable abutments for limiting the travel of the pumping piston.

2. A pump according to claim 1, wherein the valve member is in the form of a piston which is fixed to the pumping piston and which closes the inlet passage when it enters the inner end of the latter.

3. A pump according to claim 2, wherein the valve piston is hollow with a port opening into the cylinder and contains a spring-loaded buffer piston movement of which against the spring force absorbs surges of pressure at the times of closing of the inlet passage.

4. A pump according to claim 1, wherein the valve member operates and contains a non-return valve allowing the passage of liquid from the inlet passage to the cylinder.

5. A pump according to claim 4, wherein the valve member operates throughout its stroke as a piston in the inlet passage.

6. A pump according to any of the preceding claims, wherein the cylinder has a double wall provided with heating and/or cooling means and with temperature responsive means for controlling the temperature of the cylinder.

7. A pump according to any of the preceding claims, wherein the pumping piston is provided with sealing rings which surround the part of it operating in the smallest diameter section of the cylinder.

8. A pump according to any of the preceding claims, substantially as herein described with reference to the accompanying drawings.

Agents for the Applicants
STANLEY, POPPLEWELL, FRANCIS & ROSS
Chartered Patent Agents
1, Dyer's Buildings,
Holborn,
London EC1N 2JT.

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Sheet 1

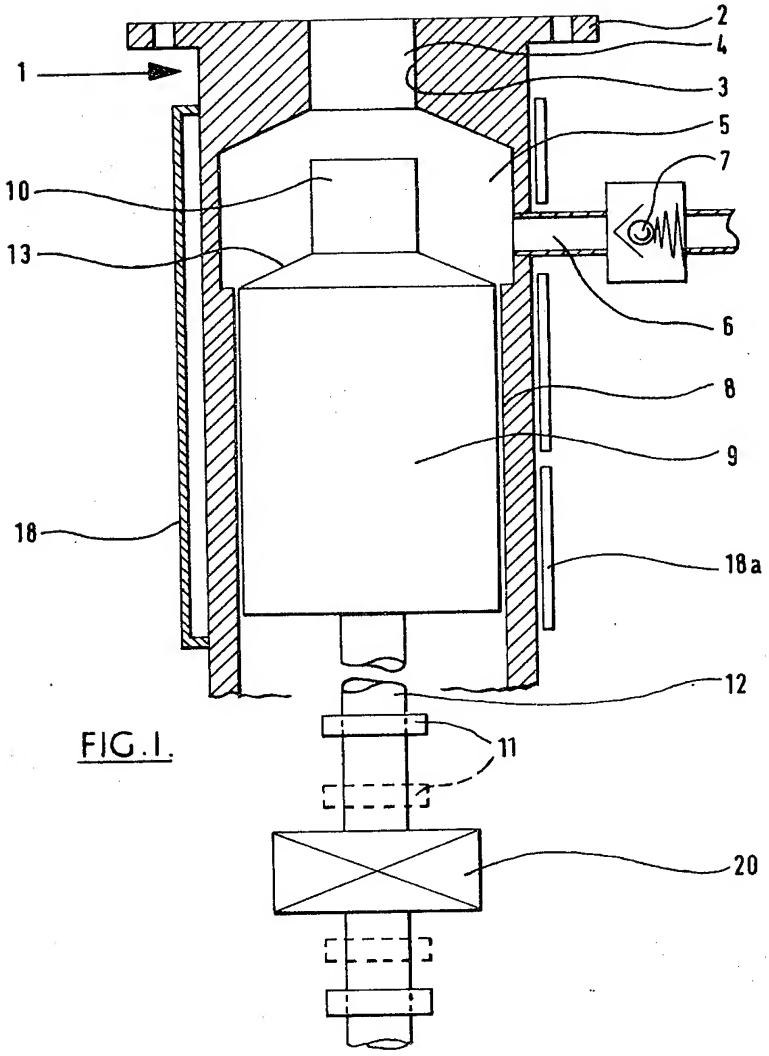

FIG.1.

1579806 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG.2.

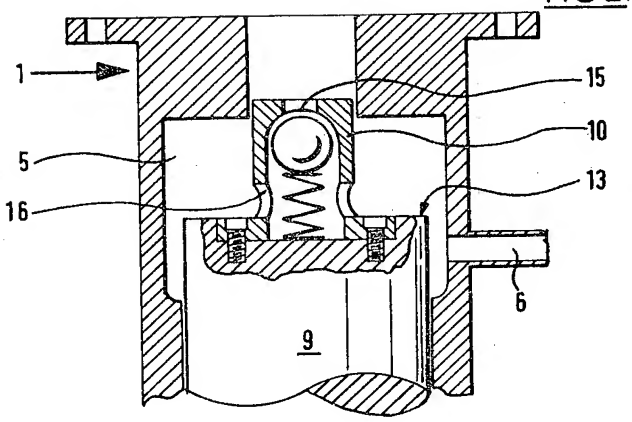

FIG.3.